Linkage Between Arctic Climate Change and Midlatitude Weather

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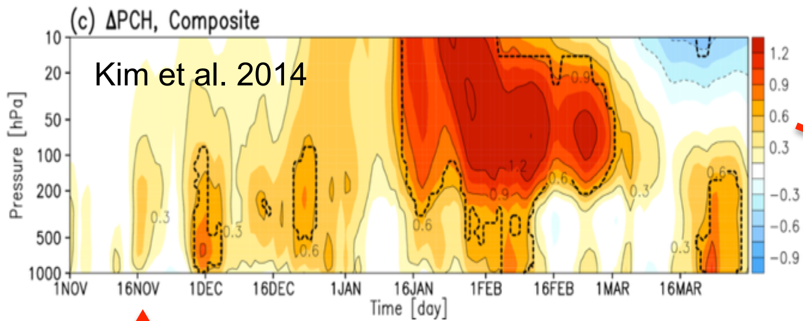
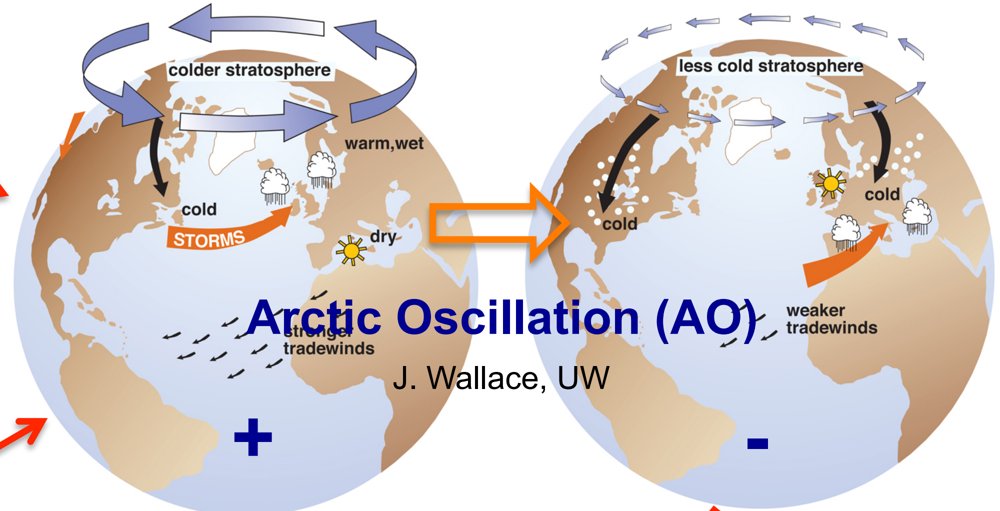
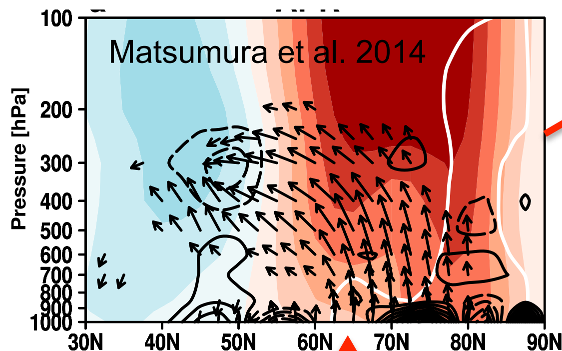
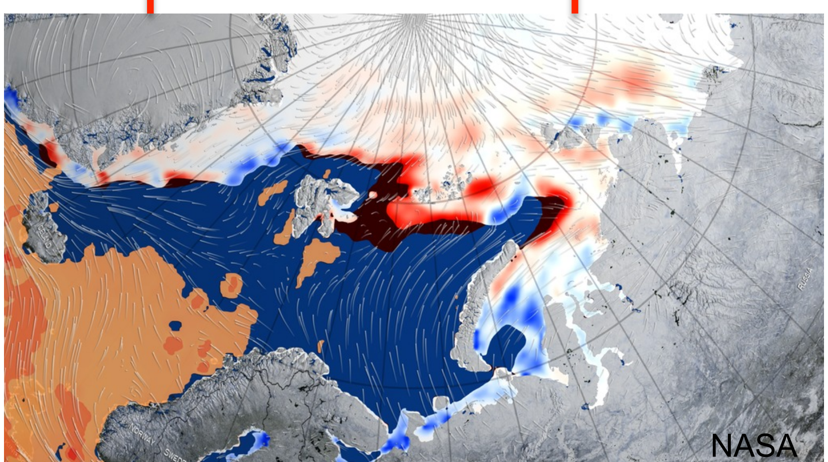
Shih-Yu (Simon) Wang, and Dave Whittleston

Atmospheric bridge linking Arctic sea ice to Eurasian cold weather



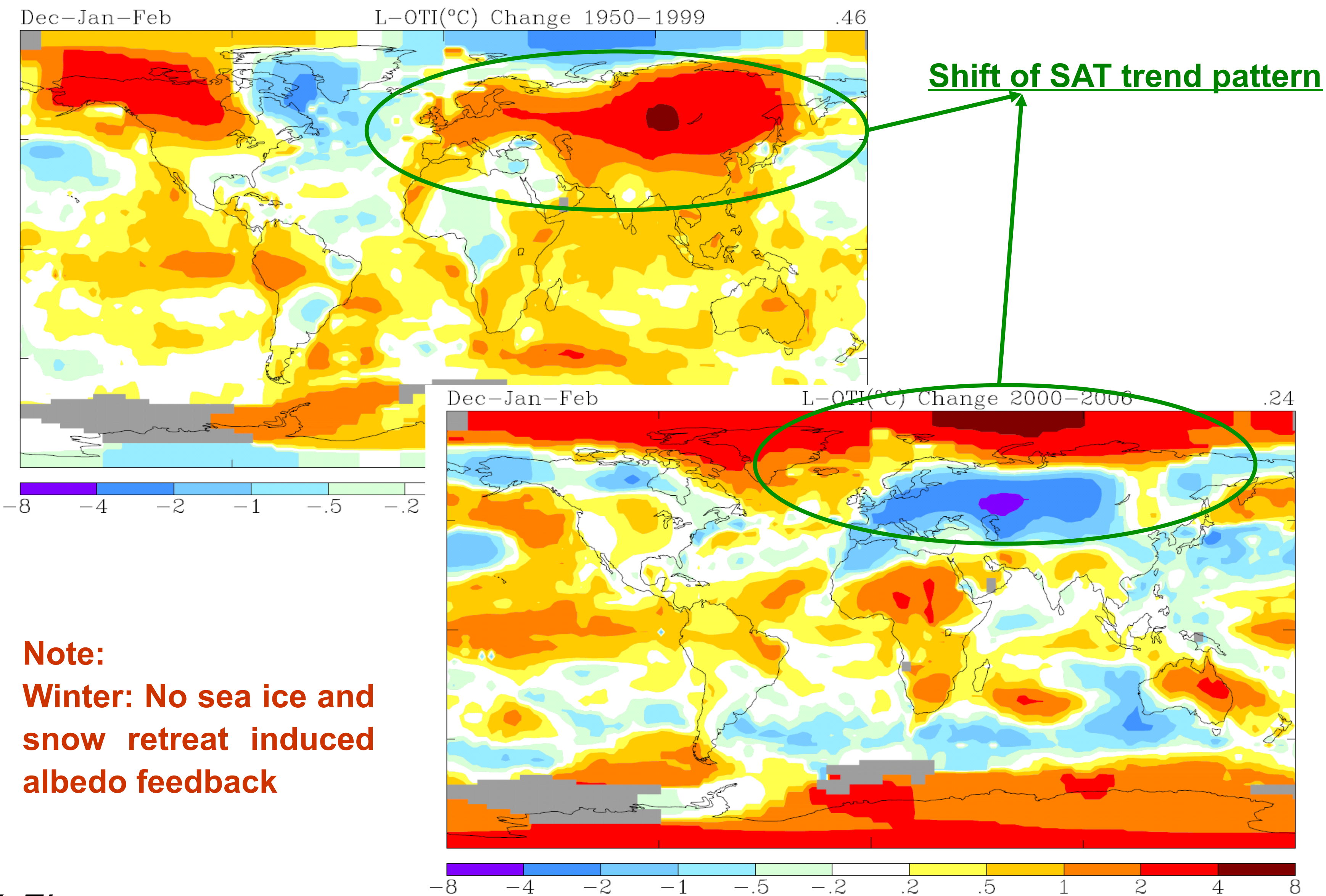






Eurasian cold winter

Arctic amplification: A spatial pattern shift

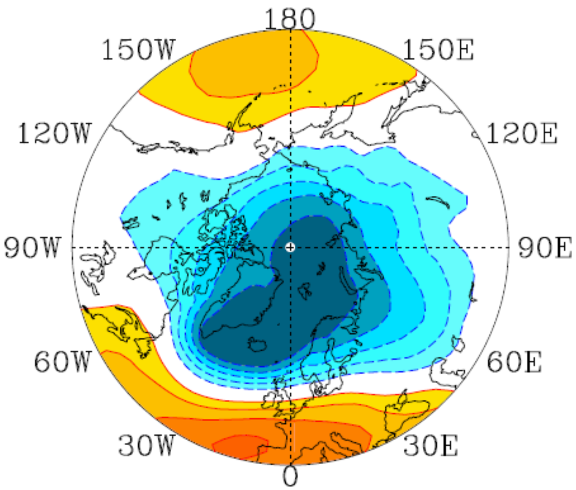


Note:
Winter: No sea ice and snow retreat induced albedo feedback

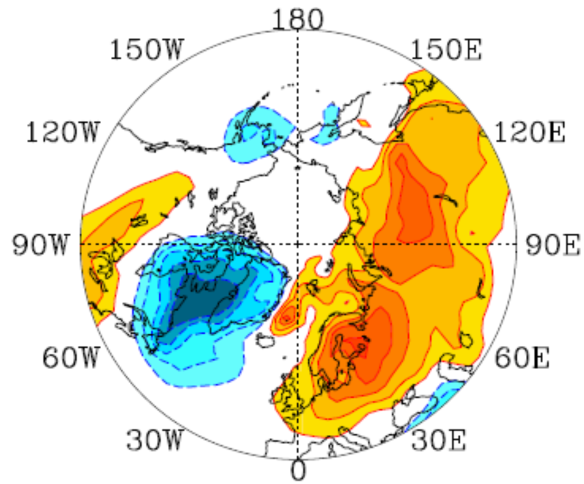
X. Zhang

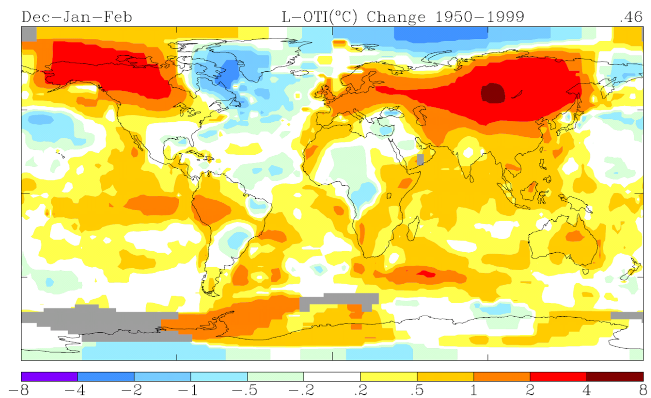
Arctic Oscillation and Arctic warming

SLP (1958-1996)

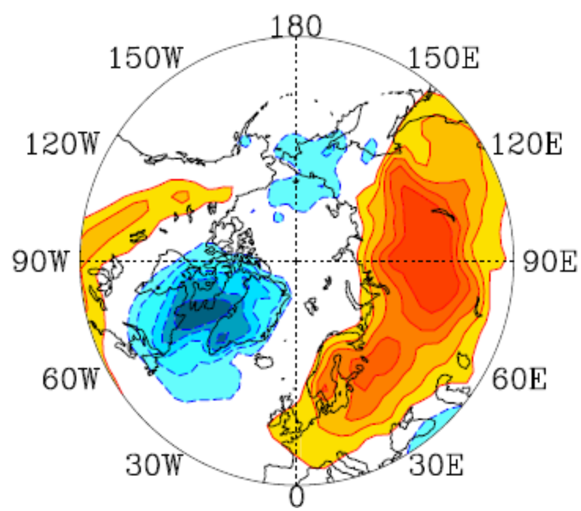


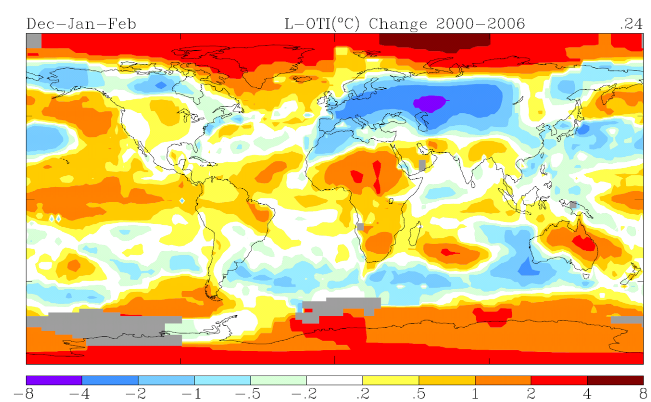
SAT(1958-1996)





SAT(1997-2016)

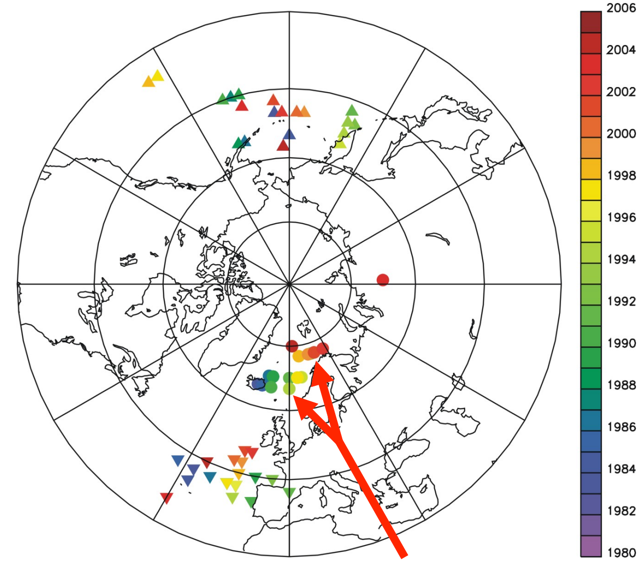




AO-driven temperature change do not capture the warming pattern shift, or Arctic amplification, or warm Arctic-cold Eurasia.

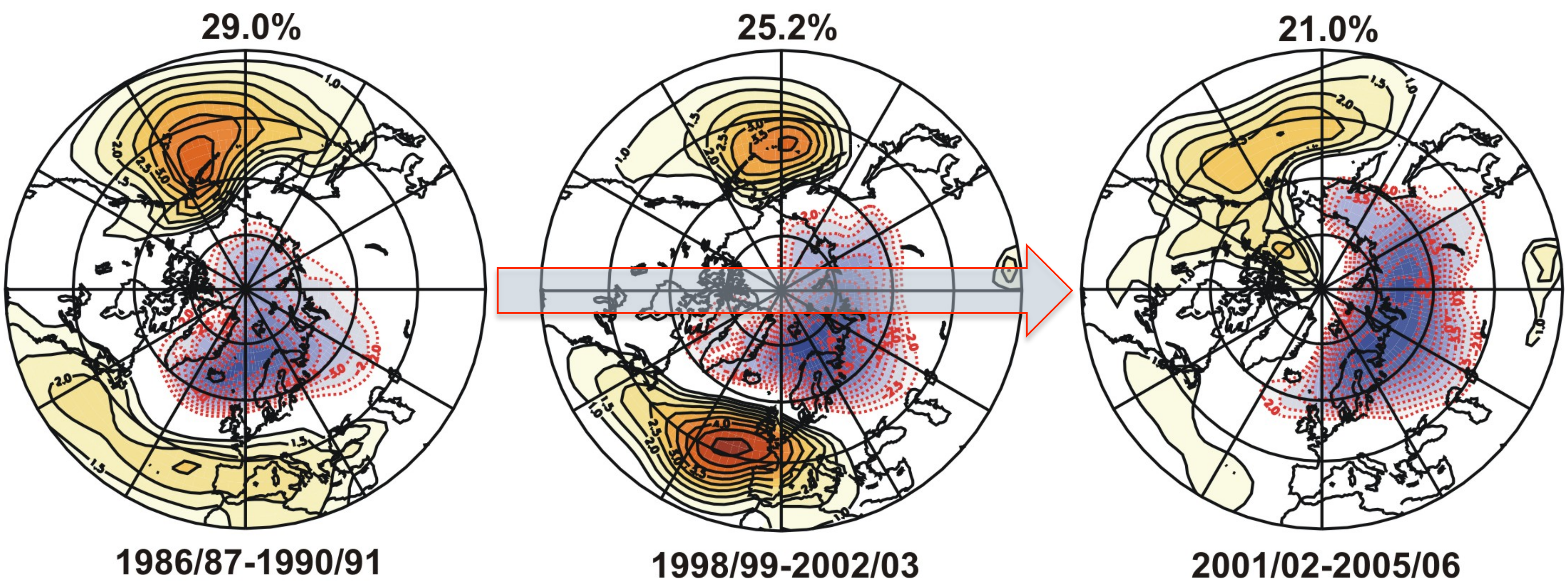
Atmospheric circulation dynamics: A spatial pattern shift and the Arctic Rapid change Pattern (ARP)

The rapidly changed Arctic from the mid-1990s to the early 2000s provide an opportunity to detect this circulation change signal.



In the mid-1990s

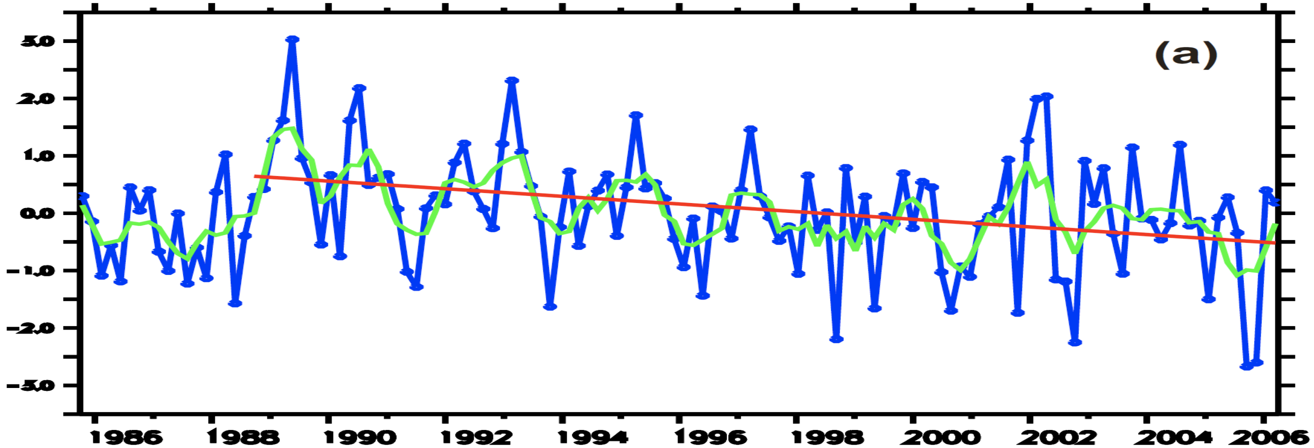
Zhang et al., 2008



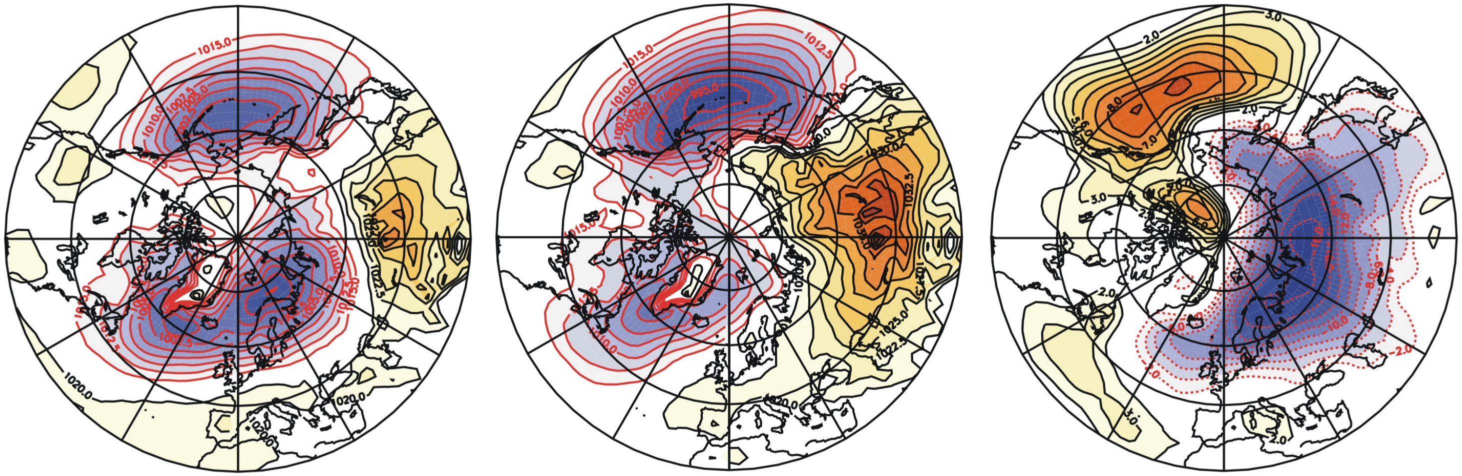
AO

ARP

What physics or dynamics does ARP represent?



Composite Analaysis Based on ARP Index



Positive ARP

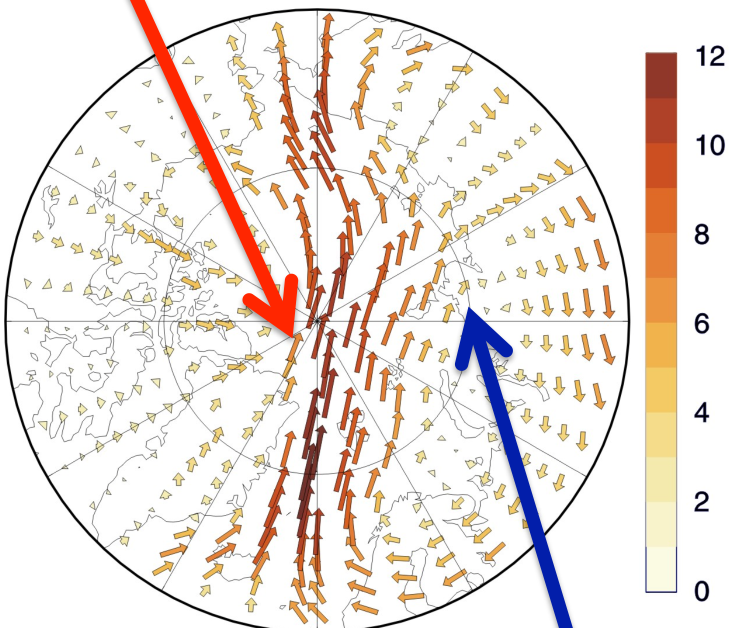
Negative ARP

Difference

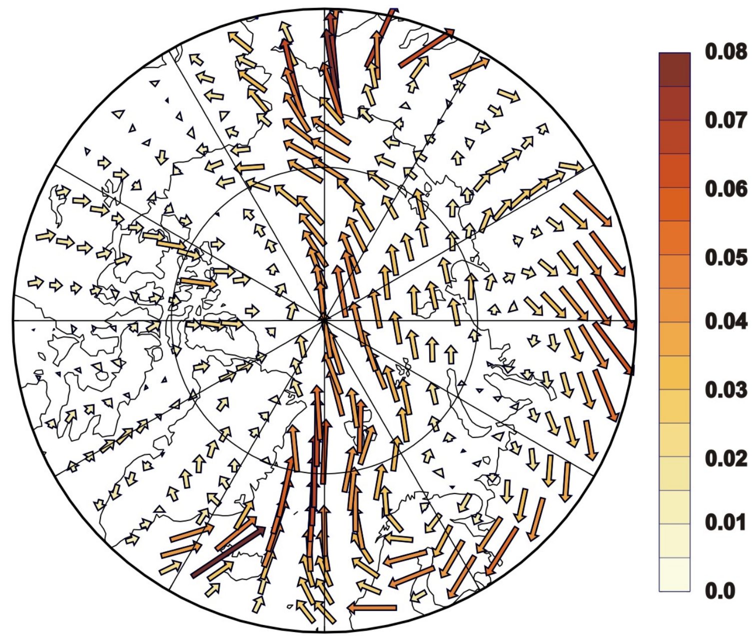
Zhang et al., 2008

ARP enhances Arctic-lower latitude interactions

provided a shortcut of atmosphere and ocean heat transport into the central Arctic from the midlatitude



Heat transport regressed onto winter ARP index (surface - 850 hpa)



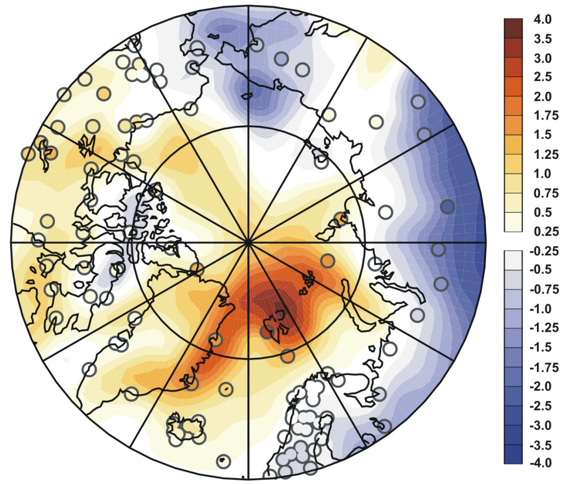
Surface wind stress regressed onto winter ARP index

re-circulate cold polar air to the midlatitude from Arctic

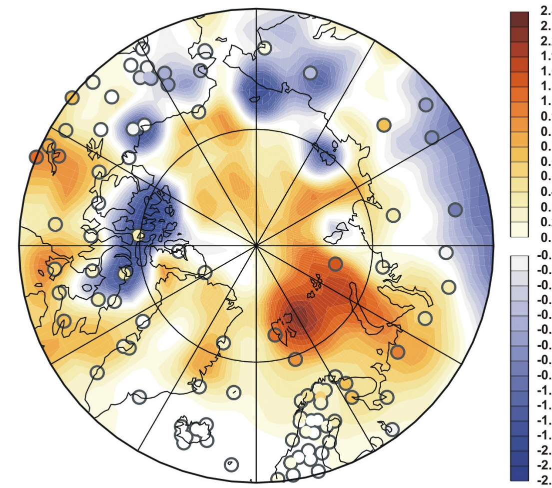
Zhang et al. (2008)

Negative polarity of ARP has caused the shift of the warming pattern and sea ice retreat

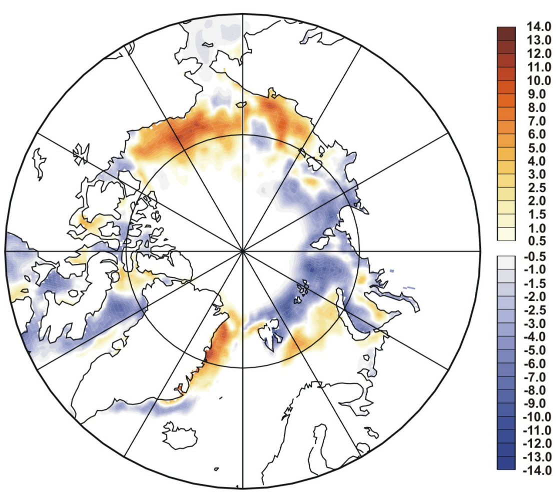
- Amplified warming over the central Arctic Ocean, and cooling over Eurasia.



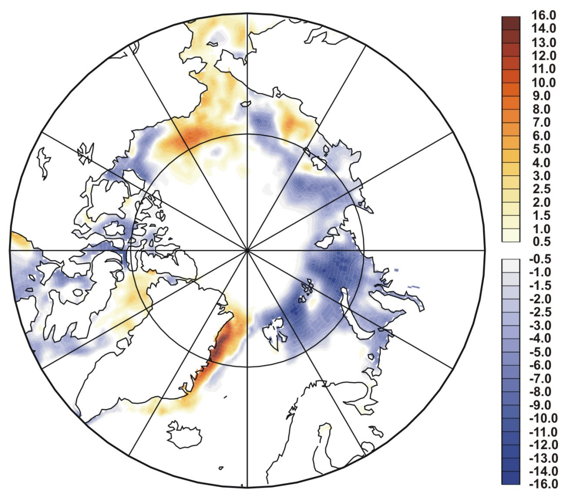
Winter Surface Air Temperature Regressed onto ARP Index



Winter Seasonal Surface Air Temperature Linear Trend



Summer Sea Ice Concentration Regressed onto ARP Index

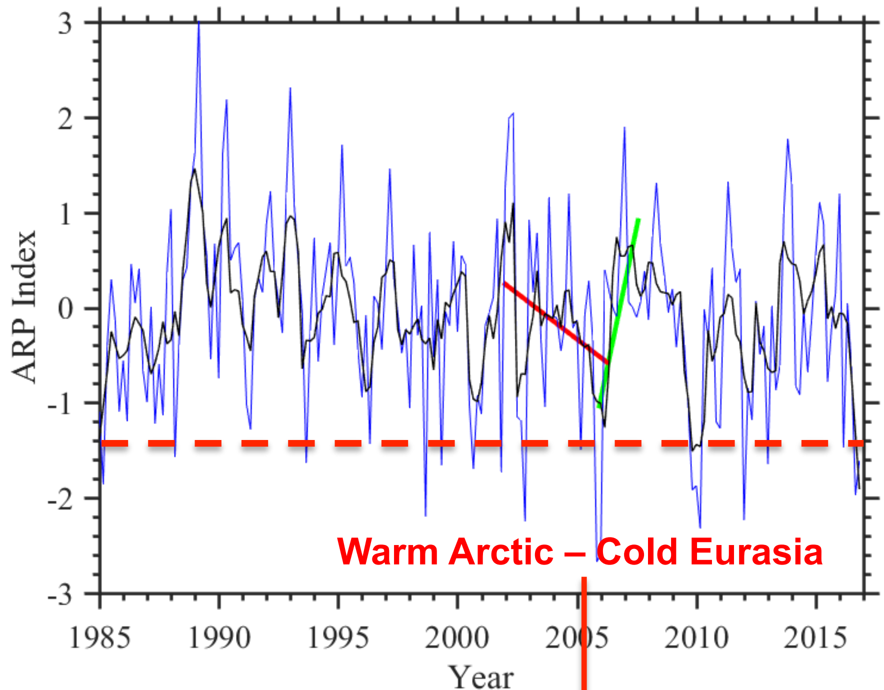


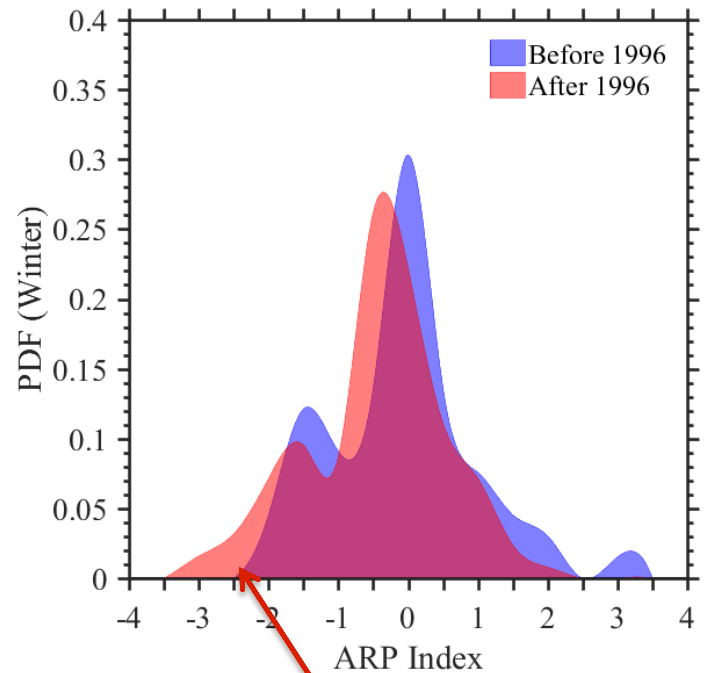
Summer Seasonal Sea ice Concentration Linear Trend

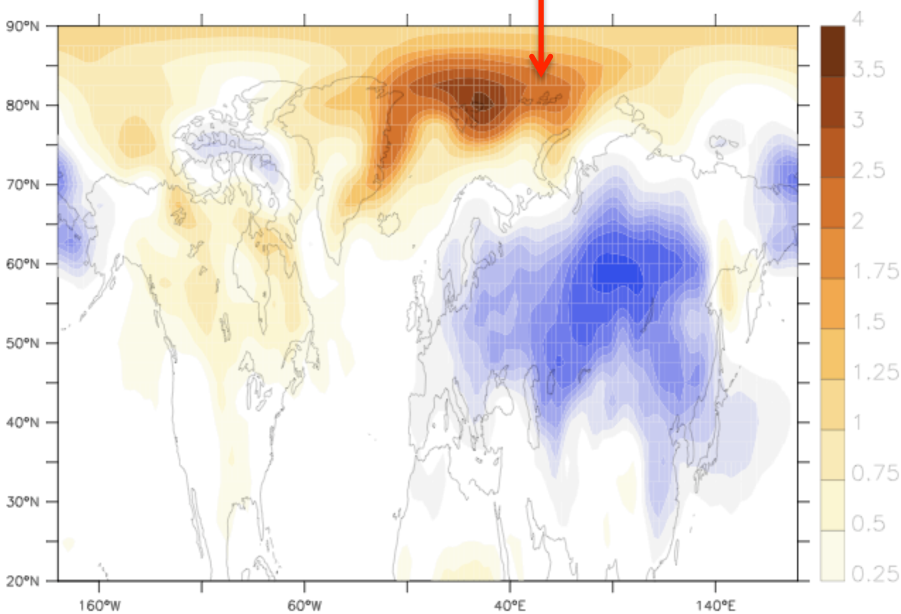
- Sea ice retreat over the Barents and Kara Seas.

Zhang et al. (2008)

Occurrence of ARP during recent years

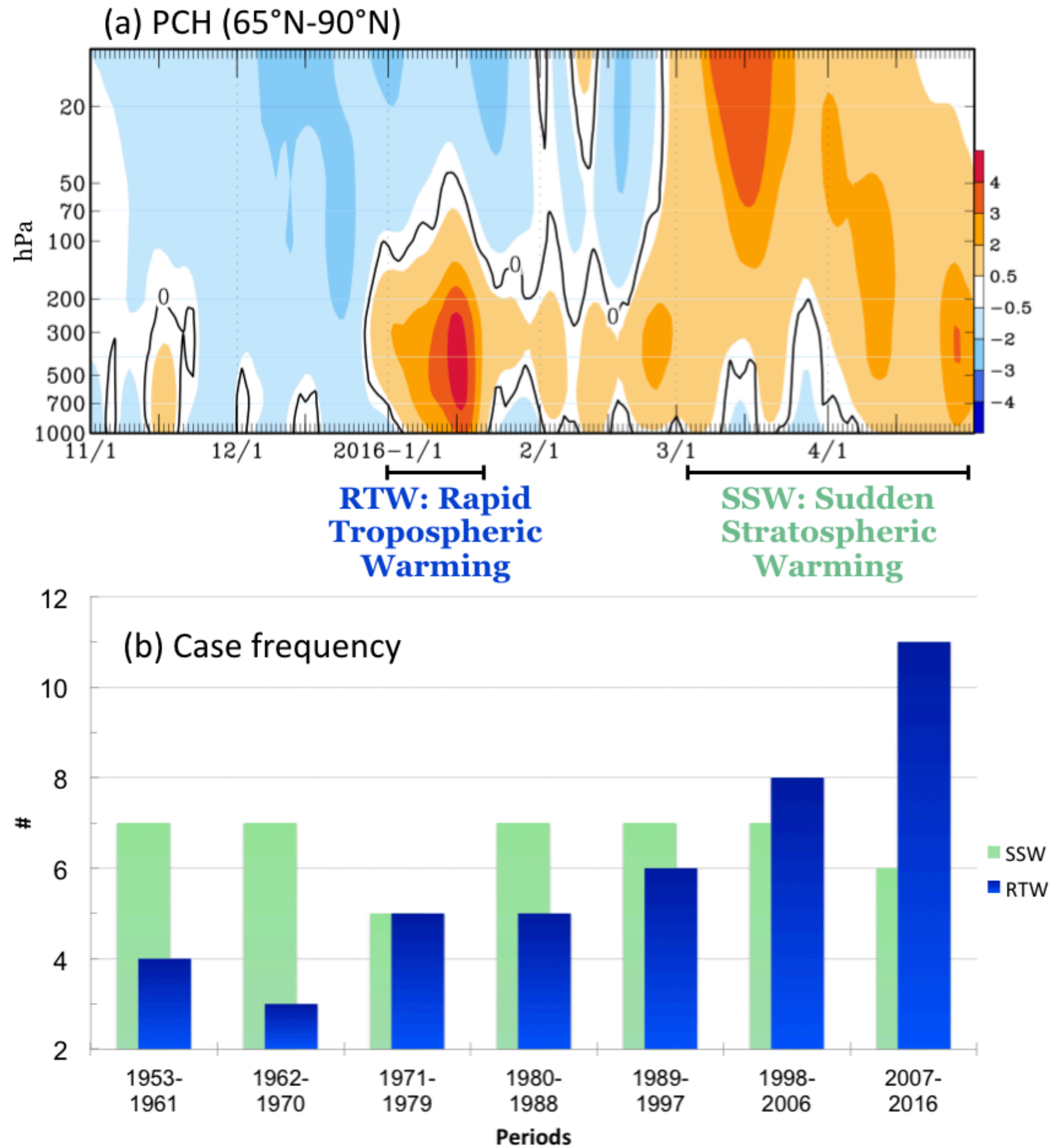






Increased frequency of the extremely negative ARP phase.

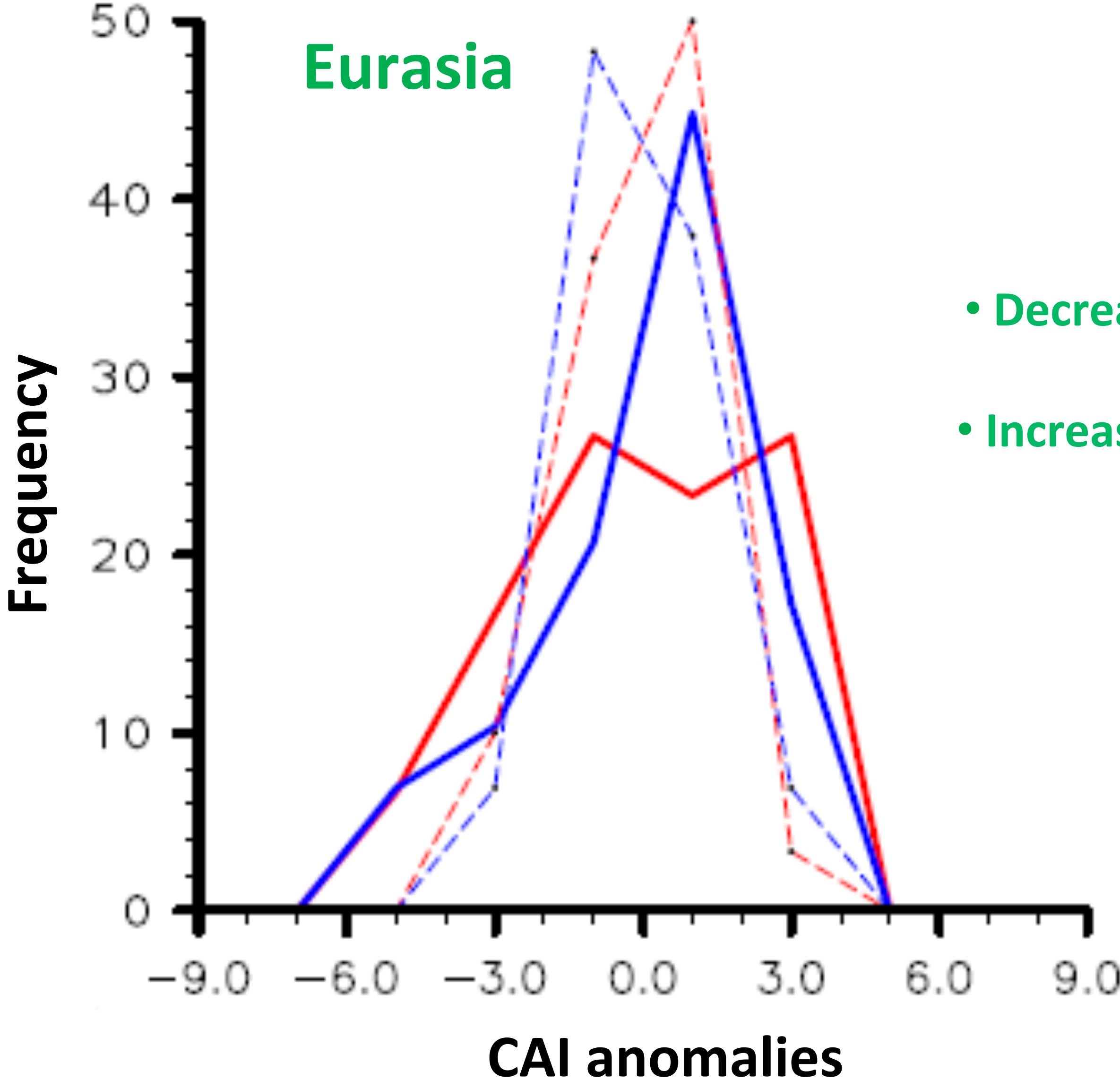
Tropospheric warming and follow-up stratospheric warming in early 2016



There is an accelerated increase in tropospheric warming since the 1990s.

Simon Wang 2017

PDF of CAI Anomaly - Conex (Blue) and Trex (Red) for DJF (solid) and MAM (dotted)



- Decreased storminess in winter
- Increased extreme storm events

Changes in Northern Hemisphere Winter Storm Tracks under the Background of Arctic Amplification

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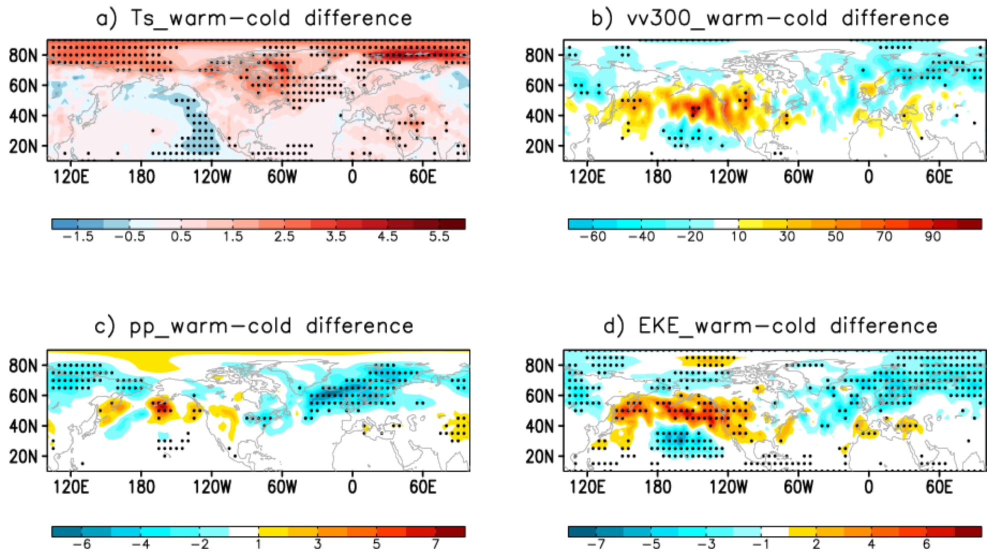
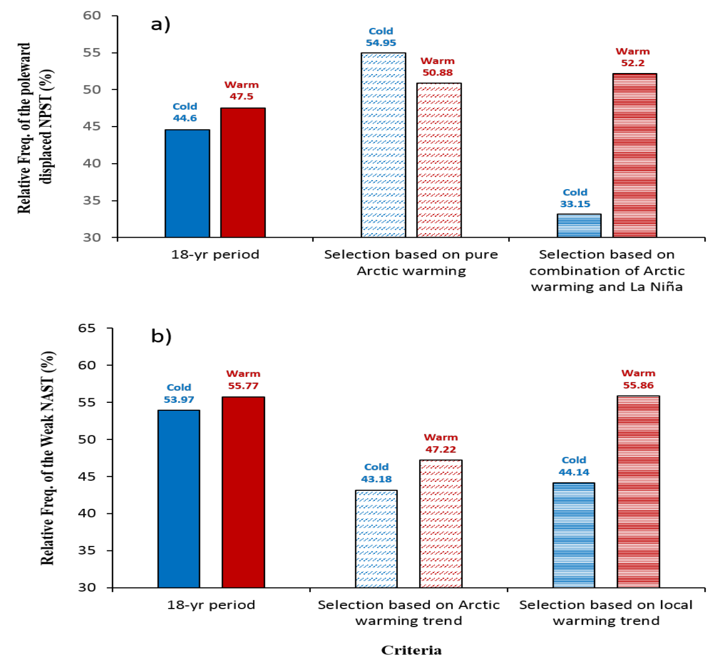
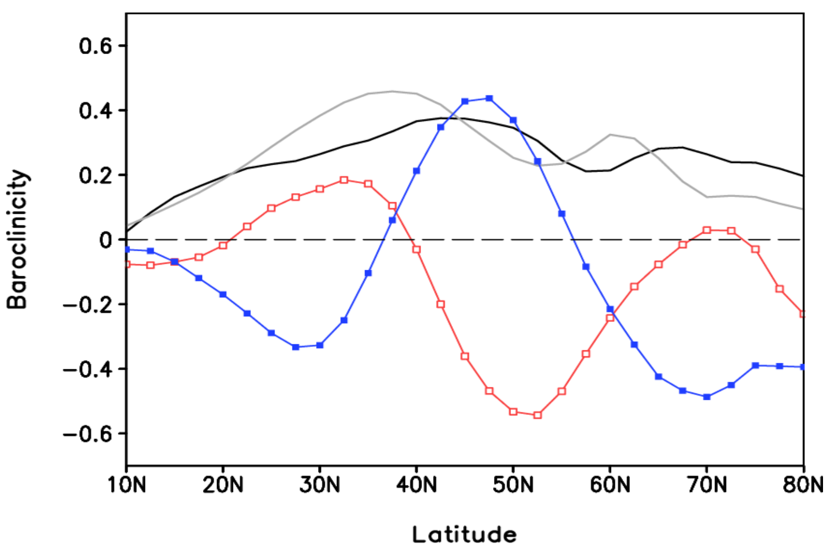
Stony Brook University
School of Marine and Atmospheric Sciences

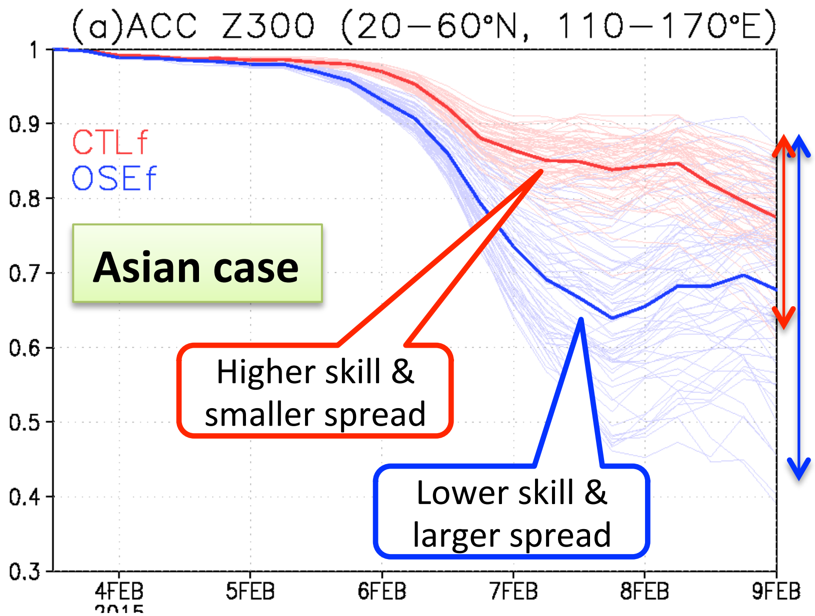


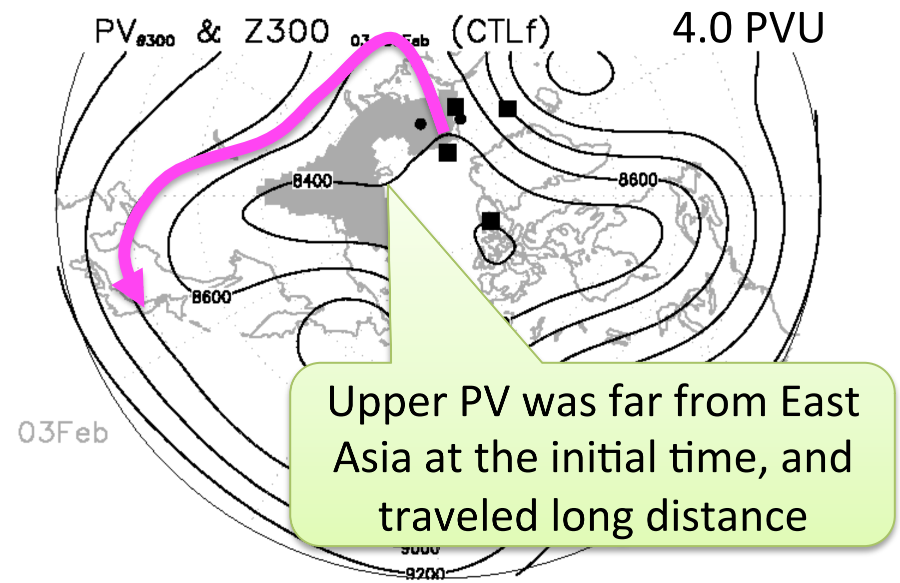


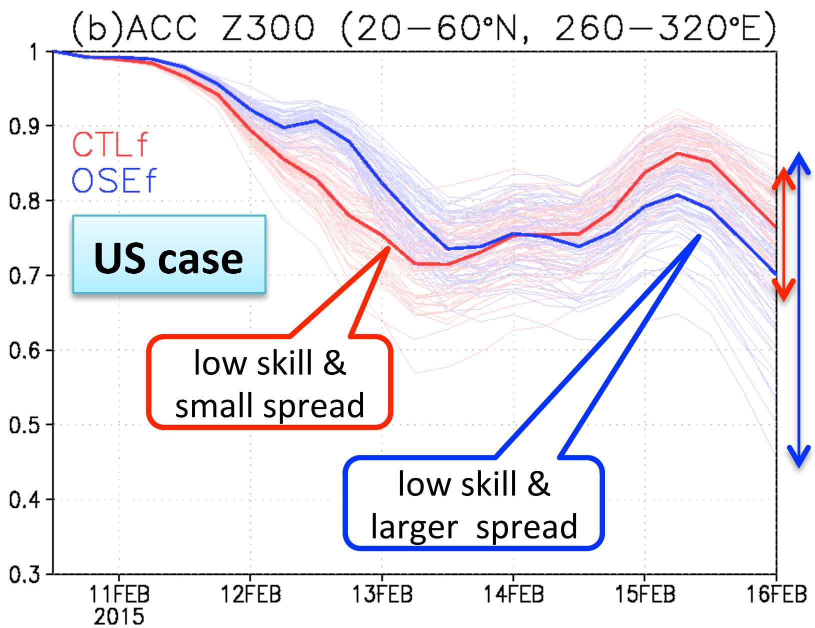


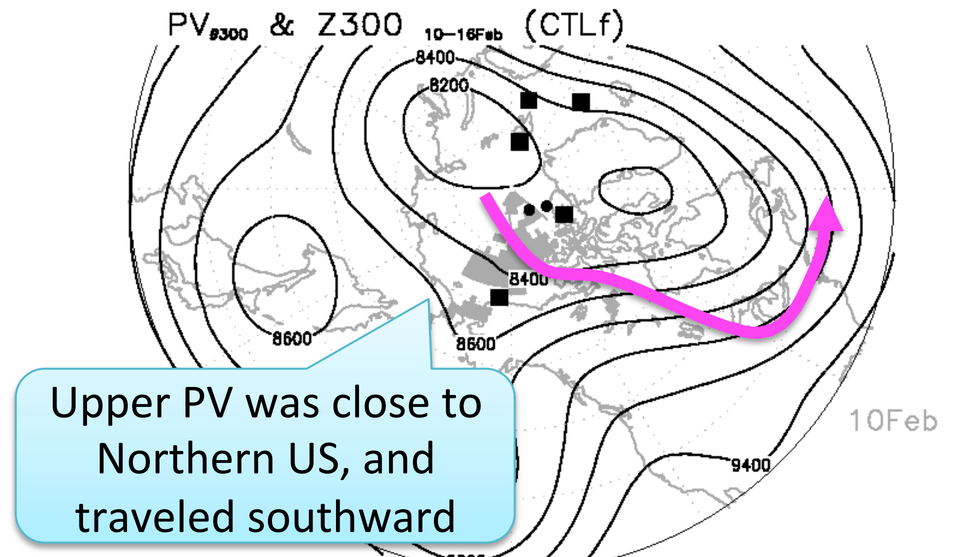
- Upper left: A weakening in the NAST and a northward shift of the NPST
- Upper right: An increase in the negative phase of the NAST. An increase in the poleward displaced NPST under the impact of Arctic warming and La Niña
- Lower left: Arctic warming and La Niña influence the changes in storm tracks via modulating baroclinicity

High PV delivers uncertainty to mid-latitudes









Sato et al. (2017, JGR-O)

Summary

- Selection of analysis metrics can influence understanding and interpretation of physics;
- Two-way linkage between the Arctic and midlatitude should be considered when selecting analysis metrics;
- Scale connection/interaction could be next step to understand occurrence of extreme events in light of impacts of Arctic climate change on midlatitude large-scale atmospheric circulation.